JP-2001-051284E

[Title of the Invention] DEVICE FOR MANUFACTURING LIQUID CRYSTAL DISPLAY DEVICE

[Abstract]

[Object] To prevent positional deviation and irregular interval generated when sticking a lower substrate and an upper substrate in a device for manufacturing a liquid crystal display device employing a liquid crystal dropping method.

[Solving Means] When the lower substrate and the upper substrate are aligned at a sticking location, a first pressurizing mechanism applies a pressurizing force to the both substrates. A second pressurizing mechanism applies a pressurizing force to the both substrates until the upper substrate is stuck to the lower substrate by an adhesive and the interval between the substrates is a predetermined value. The first pressurizing mechanism and the second pressurizing mechanism have different pressurizing forces.

[Claims]

[Claim 1] A device for manufacturing a liquid crystal display device including a first substrate consisting of light-penetrating material, a second substrate consisting of light-penetrating material and facing the first substrate, an adhesive which is coated in a ring shape along the ends

of the opposite surfaces of the both substrates, and a liquid crystal material which is filled in the gap which is formed by the adhesive and the both substrates and has a predetermined thickness, comprising:

a vacuum vessel which is hermetically sealed and evacuated to a predetermined reduced pressure;

a first suction mechanism for fixing the entire lower surface of the first substrate by a vacuum suction force;

a second suction mechanism for fixing the entire upper surface of the second substrate by a vacuum suction force;

a first pressurizing mechanism which lowers the second suction mechanism and the second substrate in a vertical direction and brings the lower surface of the second substrate into contact with the liquid crystal material or the adhesive in the vacuum vessel when the vacuum vessel is evacuated to the predetermined reduced pressure, the first pressurizing mechanism having a first pressurizing force; and

a second pressurizing mechanism which further lowers the second suction mechanism and the second substrate in the vertical direction, sticks the second substrate to the first substrate through the adhesive, and pressurizes the both substrates until the interval between the both substrates become the predetermined value in the vacuum vessel when the vacuum vessel is evacuated to the predetermined reduced

pressure, the second pressurizing mechanism having a second pressurizing force larger than the first pressurizing force.

[Claim 2] The device according to Claim 1, wherein the pressurizing force of the first pressurizing mechanism is in the range of 0.02 kgw/cm^2 to 0.6 kgw/cm^2 with respect to the first substrate and the second substrate, and the pressurizing force of the second pressurizing mechanism is in the range of 1 kgw/cm^2 to 3 kgw/cm2 with respect to the first substrate and the second substrate.

[Claim 3] The device according to Claim 1 or 2, wherein the first pressurizing mechanism or the second pressurizing mechanism uses an air cylinder or a motor as a power source.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a device for precisely manufacturing a liquid crystal display device.

[0002]

[Description of the Related Art]

A conventional device for manufacturing a liquid crystal display device will be described with reference to Figs. 2 to 4. First, Fig. 2 is a cross-sectional view showing the schematic structure of a liquid crystal display device. A regular gap is held between lower and upper substrates 4 and 6 which are opposite to each other and

consist of light-penetrating material, a liquid crystal material 8 is filled in the gap, and the both substrates 4 and 6 are stuck to each other by an adhesive 10. The adhesive 10 is an ultraviolet ray curing type and contains spacers 12 for holding regular interval (for example, a diameter of 5 μm) between the upper substrate 6 and the lower substrate 4.

[0003]

As shown in Fig. 2, the adhesive 10 is coated at the vicinity of the ends of the both substrates 4 and 6 and the liquid crystal material 8 is filled in the gap formed between the both substrates 4 and 6 and the coated adhesive 10. A method for filling the liquid crystal material in the adhesive 10 (hereinafter, referred to as a liquid crystal dropping method) is shown in Fig. 3. First, in a process (1), the adhesive 10 is coated at the vicinity of the end of the lower substrate 4 with a predetermined thickness (for example, 30 μm) and then, in a process (2), the liquid crystal material 8 is dropped in the adhesive 10. Subsequently, in a process (3), the upper substrate 6 superposes the lower substrate 4 and the both substrates 4 and 6 are vertically pressurized until the interval between the upper substrate 6 and the lower substrate 4 becomes a predetermined value (for example, 5 μm). Then, in a process (4), ultraviolet rays are irradiated to harden the adhesive

10. Thus, a liquid crystal display device is completed.

[0004]

Hereinafter, referring to Fig. 4, a liquid crystal dropping method, particularly, a process for sticking the both substrates 4 and 6 will be described.

[0005]

Process (a): First, the ultraviolet ray curing type adhesive 10 is coated on the upper surface at the vicinity of the end of the lower substrate 4 consisting of light-penetrating material with a thickness of 30 μm and a liquid crystal material 8 is arranged in the adhesive 10. The lower substrate 4 is mounted on a table 16 which can horizontally move and the entire lower surface of the lower substrate 4 is fixed by a vacuum suction force of a first suction mechanism 18. The table 16 is installed on the bottom in a vacuum vessel 24.

[0006]

Process (b): Next, the entire upper surface of the upper substrate 6 consisting of light-penetrating material is fixed by a vacuum suction force of a second suction mechanism 20. As shown, the second suction mechanism 20 includes a horizontal plate material 19 having the same size as the cross section of the vacuum vessel 24 and a seal member 21 and hermetically seals the vacuum vessel 24 below the second suction mechanism 20. Further, the second

suction mechanism 20 and the upper substrate 6 are lowered in the vertical direction by a pressurizing mechanism 22 in the vacuum vessel 24. The vacuum vessel 24 is hermetically sealed and evacuated to a predetermined reduced pressure. In this state, the upper substrate 6 is brought into contact with the liquid crystal material 8 or the adhesive 10.

[0007]

Process (c) "aligning process": The table 16 having the lower substrate 4 mounted thereon moves in the horizontal direction by a mechanism (not shown) from the outside of the vessel and the lower substrate 4 and the upper substrate 6 are aligned at a sticking location.

[0008]

Process (d) "substrate interval pressing process": The second suction mechanism 20 and the upper substrate 6 are further lowered in the vertical direction by the pressurizing mechanism 22 in the vacuum vessel 24, and the upper substrate 6 is stuck to the lower substrate 4 through the adhesive 10 and is pressurized until the interval between the both substrates becomes 5 μm.

[0009]

Process (e): Thereafter, ultraviolet rays are irradiated to the lower substrate 4 and the upper substrate 6 to harden the adhesive 10.

[0010]

For example, if the sizes of the upper substrate 6 and the lower substrate 4 are 370 mm x 470 mm, the pressurizing force of the pressurizing mechanism 22 must be approximately 500 kgw or less in the process (b) and must be proximately 1000 kgw in the process (d). That is, in the process (b), the pressurizing force is greater than 500 kgw, a resisting force of the horizontal direction which is generated between the lower substrate 4 and the upper substrate 6 obstructs the horizontal movement of the lower substrate 4 (process (c) "aligning process"). Thus, the positional deviation between the both substrates 4 and 6 is generated at a sticking location. Also, in the process (d), if the pressurizing force is less than 1000 kgw, the resisting force of the vertical direction which is generated between the adhesive 10 or the liquid crystal material 8 and the upper substrate 6 obstructs the vertical movement of the upper substrate 6. Thus, the substrates can not be pressurized so that the interval between the both substrates 4 and 6 becomes a predetermined value (5 μm).

[0011]

[Problems to be Solved by the Invention]

In the conventional device, if the pressurizing mechanism 22 having the pressurizing force required for the substrate interval pressing process is used, the precision of the aligning operation is not sufficiently high in the

aligning process. In the above-mentioned example, if the pressurizing mechanism 22 having the pressurizing force of 1000 kgw or more, the precision of the aligning operation is not sufficiently high. At this time, the positional deviation between the both substrates 4 and 6 is apt to be generated.

[0012]

In order to align the both substrates with sufficiently high precision, the pressurizing force of the pressurizing mechanism 22 must be reduced. Thus, in the substrate interval pressing process, the both substrates can not be pressurized so that the interval between the both substrates 4 and 6 uniformly becomes the predetermined value, and thus the precision required for the interval between the both substrates 4 and 6 can not be obtained. In case of the above-mentioned example, if the pressurizing mechanism 22 having the pressurizing force of 500 kgw or less is used so as to obtain sufficiently high precision of the aligning operation in the aligning process, the both substrates can not be pressurized so that the both substrates 4 and 6 uniformly becomes 5 μm, and thus the interval between the both substrates 4 and 6 can not uniformly become 5 μm with high precision.

[0013]

The present invention is to provide a device for

manufacturing a liquid crystal display device which prevents the positional deviation and irregular interval generated when sticking the lower substrate 4 and the upper substrate 6 and thus reduces the defect such as irregular image of the liquid crystal display device 2.

[0014]

[Means for Solving the Problems]

The present invention is to sole the problems. Accordingly, the present invention to A device for manufacturing a liquid crystal display device including a first substrate consisting of light-penetrating material, a second substrate consisting of light-penetrating material and facing the first substrate, an adhesive which is coated in a ring shape along the ends of the opposite surfaces of the both substrates, and a liquid crystal material which is filled in the gap which is formed by the adhesive and the both substrates and has a predetermined thickness, comprising: a vacuum vessel which is hermetically sealed and evacuated to a predetermined reduced pressure; a first suction mechanism for fixing the entire lower surface of the first substrate by a vacuum suction force; a second suction mechanism for fixing the entire upper surface of the second substrate by a vacuum suction force; a first pressurizing mechanism which lowers the second suction mechanism and the second substrate in a vertical direction and brings the

lower surface of the second substrate into contact with the liquid crystal material or the adhesive in the vacuum vessel when the vacuum vessel is evacuated to the predetermined reduced pressure, the first pressurizing mechanism having a first pressurizing force; and a second pressurizing mechanism which further lowers the second suction mechanism and the second substrate in the vertical direction, sticks the second substrate to the first substrate through the adhesive, and pressurizes the both substrates until the interval between the both substrates become the predetermined value in the vacuum vessel when the vacuum vessel is evacuated to the predetermined reduced pressure, the second pressurizing mechanism having a second pressurizing force larger than the first pressurizing force.

[0015]

It is preferable that the pressurizing force of the first pressurizing mechanism is in the range of 0.02 kgw/cm^2 to 0.6 kgw/cm^2 with respect to the first substrate and the second substrate, and the pressurizing force of the second pressurizing mechanism is in the range of 1 kgw/cm^2 to 3 kgw/cm2 with respect to the first substrate and the second substrate.

[0016]

It is preferable that the first pressurizing mechanism or the second pressurizing mechanism uses an air cylinder or a

motor as a power source.

[0017]

[Description of the Embodiments]

Hereinafter, an embodiment of the present invention will be described with reference to Fig. 1. Fig. 1 is a schematic cross-sectional view of a device for manufacturing a liquid crystal display device an embodiment of the present invention and shows a liquid crystal dropping method using the device by successive processes (a) to (e).

[0018]

Process (a): This process is equal to that of the prior art. That is, first, the ultraviolet ray curing type adhesive 10 is coated on the upper surface at the vicinity of the end of the lower substrate 4 consisting of light-penetrating material with a thickness of 30 μm and a liquid crystal material 8 is arranged in the adhesive 10. The lower substrate 4 is mounted on a table 16 which can horizontally move and the entire lower surface of the lower substrate 4 is fixed by a vacuum suction force of a first suction mechanism 18. The table 16 is installed on the bottom in a vacuum vessel 24.

[0019]

Process (b): Next, the entire upper surface of the upper substrate 6 consisting of light-penetrating material is fixed by a vacuum suction force of a second suction

mechanism 20. Similar to the prior art, as shown, the second suction mechanism 20 includes a horizontal plate material 19 having the same size as the cross section of the vacuum vessel 24 and a seal member 21 and hermetically seals the vacuum vessel 24 below the second suction mechanism 20. Further, the second suction mechanism 20 and the upper substrate 6 are lowered in the vertical direction by a first pressurizing mechanism 26 having a first pressurizing force in the vacuum vessel 24. The vacuum vessel 24 is hermetically sealed and evacuated to a predetermined reduced pressure. In this state, the upper substrate 6 is brought into contact with the liquid crystal material 8 or the adhesive 10. As mentioned below, the first pressurizing mechanism 26 is different from a second pressurizing mechanism 28.

[0020]

Process (c) "aligning process": This process is equal to that of the prior art. The table 16 having the lower substrate 4 mounted thereon moves in the horizontal direction by a mechanism (not shown) from the outside of the vessel and the lower substrate 4 and the upper substrate 6 are aligned at a sticking location. Here, the first pressurizing force is applied to the lower substrate 4 and the upper substrate 6 and, in this state, the aligning operation is performed.

[0021]

Process (d) "substrate interval pressing process": the second suction mechanism 20 and the upper substrate 6 are further lowered in the vertical direction by the second pressurizing mechanism 28 having a second pressurizing force in the vacuum vessel 24, and the upper substrate 6 is stuck to the lower substrate 4 through the adhesive 10 and is pressurized until the interval between the both substrates becomes 5 μm. Here, as shown, the second pressurizing mechanism 28 is different from the first pressurizing mechanism 26 and the second pressurizing force is larger than the first pressurizing force.

[0022]

Process (e): Thereafter, ultraviolet rays are irradiated to the lower substrate 4 and the upper substrate 6 to harden the adhesive 10.

[0023]

According to the above-mentioned device, the precision of the aligning operation is sufficiently high in the aligning process and the positional deviation between the lower substrate 4 and the upper substrate 6 is not generated. Thereby, the defect such as irregular image of the liquid crystal display device 2 is reduced. Also, since the pressurizing force of the second pressurizing mechanism 28 is sufficiently large in the substrate interval pressing

process, the both substrates can be pressurized so that the interval between the both substrates 4 and 6 becomes the predetermined value. Thereby, the irregular gap is reduced and thus the defect such as irregular image of the liquid crystal display device 2 is reduced.

[0024]

Next, the values of the first pressurizing force and the second pressurizing force will be examined.

[0025]

In the device for manufacturing the liquid crystal display device, the first pressurizing force of the first pressurizing mechanism 26 is less than 0.02 kgw/cm^2 with respect to the upper substrate 6 and the lower substrate 4, the state of sticking the upper substrate 6, the liquid crystal material 8 or the adhesive 10, and the lower substrate 4 is not stable. Accordingly, although the lower substrate 4 and the upper substrate 6 are aligned at a sticking location, the positions thereof may be deviated in the following process. Also, if the first pressurizing force of the first pressurizing mechanism 26 is larger than 0.6 kgw/cm^2 with respect to the upper substrate 6 and the lower substrate 4, the resisting force of the horizontal direction which is generated between the lower substrate 4 and the upper substrate 6 obstructs the horizontal movement of the lower substrate 4 and thus the both substrates 4 and

6 can not be aligned at the sticking location. Accordingly, the first pressurizing force of the first pressurizing mechanism 26 for the upper substrate 6 and the lower substrate 4 is preferably in the range of 0.02 kgw/cm^2 to 0.6 kgw/cm^2.

[0026]

On the other hand, in the substrate interval pressing process of the device for manufacturing the liquid crystal display device, the interval between the upper substrate 6 and the lower substrate 4 must be sufficiently a narrow value. Thereby, the second pressurizing force of the second pressurizing mechanism 28 for the upper substrate 6 and the lower substrate 4 is preferably in the range of 1 kgw/cm^2 to 3 kgw/cm^2. Also, in consideration with the total cost of the device, the second pressurizing force is preferably less than 2 kgw/cm^2.

[0027]

The shapes of the first pressurizing mechanism 26 and the second pressurizing mechanism 28 are not specially limited. For example, the first pressurizing mechanism 26 and the second pressurizing mechanism 28 may use an air cylinder or a motor as a power source.

[0028]

[Advantages]

If the method for manufacturing the liquid crystal

display device according to the present invention is used, the precision of the aligning operation is sufficiently high in the aligning process and the positional deviation between the lower substrate (first substrate) and the upper substrate (second substrate) is not generated. Thereby, the defect such as irregular image of the liquid crystal display device is reduced. Also, since the pressurizing force of the second pressurizing mechanism is sufficiently large in the substrate interval pressing process, the both substrates can be pressurized so that the interval between the both substrates becomes the predetermined value. Thereby, the irregular gap is reduced and thus the defect such as irregular image of the liquid crystal display device is reduced.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a schematic cross-sectional view of a device for manufacturing a liquid crystal display device an embodiment of the present invention and shows a liquid crystal dropping method using the device by successive processes (a) to (e).

[Fig. 2]

Fig. 2 is a cross-sectional view showing the schematic structure of a liquid crystal display device.

[Fig. 3]

Fig. 3 schematically shows a liquid crystal dropping method.

[Fig. 4]

Fig. 4 is a schematic cross sectional view of a conventional device for manufacturing a liquid crystal display device and shows a liquid crystal dropping method using the device by successive processes (a) to (e).

[Reference Numerals]

2: liquid crystal display device

4: lower substrate

6: upper substrate

8: liquid crystal material

10: adhesive

12: spacer

14: ultraviolet ray source

16: table

18: first suction mechanism

19: horizontal plate material

20: second suction mechanism

21: seal material

22: pressurizing mechanism

24: vacuum vessel

26: first pressurizing mechanism

28: second pressurizing mechanism